

User's Manual


Models FP201/FP201A

High Accurate Pressure Sensor




Please read through this User's Manual before use for correct handling.
Please keep this User's Manual for future reference.

For safety:
The following symbol is used on the product and in this manual to ensure safe use:

 indicates caution. This symbol is displayed on the product when it is necessary to refer to the User's Manual for information on personnel and instrument safety. This symbol is displayed in the User's Manual to indicate precautions for avoiding danger to the operator, such as an electric shock.

The following symbol is used only in this manual:

 **NOTE** draws attention to essential information for understanding the operations and/or functions of the product.

1st Edition : Jul. 2002 (MC)
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IM 01C10B11-01E
3rd Edition: Nov. 2004 (YK)

1. PRODUCT INSPECTION

The FP201/FP201A pressure sensors are shipped only after stringent inspection at the factory. Upon delivery, check the sensor according to the instructions given below.

- (1) Visually check the sensor to ensure that it is free from damage.
- (2) The model and suffix codes and the pressure range are indicated on the data plate attached to the sensor. Cross-check this information with that in Table 2, "Model and Suffix Codes" to ensure that the sensor is as specified in the order.

Note: If the specifications of the ordered sensor are not standard, refer to the label tag attached to the sensor.

2. HANDLING PRECAUTIONS

2.1 Storage

- (1) Store the sensor in a location that meets the following requirements.
 - No exposure to rain or water
 - No major mechanical vibration or shocks
 - Humidity and temperature within the following ranges—preferably as close as possible to the normal condition (25°C, 65% RH)
Temperature: -20 to 80°C; humidity: 5 to 95% RH (non-condensing)
 - No corrosive gases
- (2) Whenever possible, store the sensor in the same packaging that it was shipped in by the manufacturer.
- (3) If the sensor has been put into use and the pressure-sensing chamber contains fluids, clean the chamber thoroughly before storing the sensor. Even when cleaning the sensor, exercise care to avoid damaging the seal diaphragms.

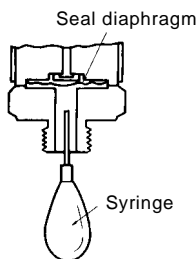


Figure 1 Cleaning of the Pressure-sensing Chamber Interior

2.2 Installation Location



CAUTION

Never use the sensor in an environment containing any explosive gas. It is not designed to be explosion-proof.

Although the FP201/FP201A pressure sensors are designed for use in severe environment, the following precautions should be observed to ensure that the sensors are used safely and that they achieve the required accuracy for a prolonged period.

- (1) If it is likely that the sensor will be exposed to direct sunlight and/or other radiated heat, prepare some kind of heat insulation for the sensor.
- (2) Avoid installing the sensor in an environment containing any corrosive gas.
- (3) Although the sensor is designed to be water-resistant, avoid installing it in a location exposed to splashes of rain.
- (4) Although the sensor is durable for vibration, install it in a location where mechanical vibration and/or shocks are minimal.

2.3 Precautions to Avoid Damaging the Sensor

- (1) When measuring pressure or cleaning the sensor, exercise care to avoid damaging the seal diaphragms (see Section 3.3, "Components").
- (2) The seal diaphragm may be damaged if the measured fluid within the pressure-sensing chamber freezes. If it is likely to occur, prepare some kind of heat insulation etc. to avoid measured fluid from freezing.
- (3) When measuring liquid pressure (especially in vacuum or high pressure condition), sudden pressure change causes impulse pressure. Mount a damper (a fitting for dampening the pulsating pressure) or the like to keep the pressure within the maximum allowable pressure (see Table 1).

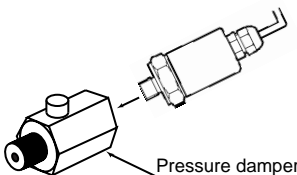


Figure 2

2.4 Insulation Resistance and Withstanding Voltage Test Procedures



CAUTION

Carry out these tests only when absolutely necessary. Mistake in testing may result in electric shock to the operator or damaging the sensor.

- (1) Short-circuit the + and - lead wires. For each test, apply the following voltages across the lead wires and the ground lead wire.
 - Insulation Resistance Test: 500 V DC, for 2 minutes max.
Make sure the insulation resistance is 20 MΩ or more.
 - Withstanding Voltage Test: 500 V AC, for 1 minute max.
Make sure the leak current is 1 mA or less.
- (2) After the tests, connect a 100 kΩ resistor across the short-circuited two lead wires and the ground lead wire in order to discharge any internal charge.

3. PRODUCT OVERVIEW

The FP201/FP201A pressure sensors can be used to measure gauge or absolute pressure and output a 4 to 20 mA DC current signal corresponding to the measured pressure. The FP201/FP201A can measure gas and liquid pressures directly with high accuracy and performance (e.g. temperature effects), along with long-term stability.

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Field Instruments Business Division

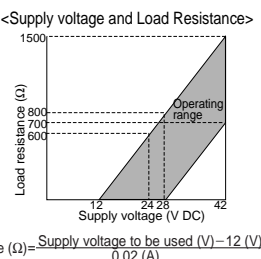
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3.1 Specifications

Table 1 Measuring Range

Code	Range in Pa	Maximum Allowable Pressure
J	-100k to 0	200 kPa
N	-100k to 100k	400 kPa
M	-100k to 300k	800 kPa
T	0 to 10k	50 kPa
S	0 to 20k	100 kPa
K	0 to 50k (abs)	100 kPa
L	0 to 100k (abs)	200 kPa
A	0 to 200k (abs)	400 kPa
B	0 to 500k (abs)	1 MPa
C	0 to 1M (abs)	2 MPa
D	0 to 2M (abs)	4 MPa
E	0 to 5M (abs)	10 MPa
F	0 to 10M	20 MPa
G	0 to 20M	40 MPa
H	0 to 35M	50 MPa



* The FP201A absolute-pressure sensor has only seven measuring ranges: 50 kPa abs, 100 kPa abs, 200 kPa abs, 500 kPa abs, 1 MPa abs, 2 MPa abs, and 5 MPa abs.

Measurement accuracy^{(Note 1)(Note 5)}: ±0.25% of span (including linearity, hysteresis and repeatability)

10 kPa range: ±0.5% of span (including linearity, hysteresis and repeatability)

20 kPa range: ±0.35% of span (including linearity, hysteresis and repeatability)

Process connection R1: ±0.3% of span (including linearity, hysteresis and repeatability)

Temperature effect (zero point) [% of span/°C]^(Note 4): ±0.02 for the range of 200 kPa or more, ±0.05 for the range of 100 kPa or -100 kPa, ±0.03 for the range of -100 k to 100 kPa or -100 k to 300 kPa, ±0.08 for the range of 20 kPa or 50 kPa, or ±0.1 for the range of 10 kPa

Compensation temperature range^(Note 4): -25 to 75°C, -10 to 75°C for the range of 10 kPa or 20 kPa, 0 to 60°C (Process connection R1; 50 kPa (abs), 100 kPa (abs)), 0 to 75°C (Process connection R1; other ranges except for the above)

Operating temperature range: -40 to 80°C^(Note 2)

Supply voltage effect (zero point): ±0.005% of span/V

Attitude error: Approx. 30 Pa/90° (Measuring range ≥ 30 kPa), approx. 60 Pa/90° (Measuring range < 30 kPa), approx. 400 Pa/90° (Process connection R1) 4 to 20 mA DC, two-wire

Output signal:

Measured fluid: Liquid or gas

Vacuum pressure: 2.7 kPa abs or more; Note that negative pressure must not be applied when the range is 50 kPa (gauge pressure) or less.

Supply voltage: 12 to 28 V DC (recommended voltage: 24 V DC ± 10%) See Graph above.

Load resistance: 0 to 600 Ω (at 24 V DC power supply) See Graph above.

Process connection: G1/4, 3/8, 1/2 (PF1/4, 3/8, 1/2), or R1/4, 3/8, 1/2, 1 (PT1/4, 3/8, 1/2, 1)

Material: Diaphragm: Hastelloy-C; nipple connector: SUS316; fill fluid: silicone oil; case: aluminum alloy; O-ring: fluoro rubber (viton) Approx. 350 g (Measuring range < 30 kPa), approx. 230 g (30 kPa ≤ Measuring range ≤ 5 MPa), approx. 260 g (Measuring range > 5 MPa, approx. 410 g (Process connection R1)

Weight: 20 MΩ or more/500V DC

Insulation resistance: 500 V AC for 1 minute, 1 mA or less

Withstanding voltage: EN61326

EMC standards: 100 m/s² (in 3 directions for 2 hours at 150 Hz or less)

Vibration resistance: 1000 m/s² (in 3 directions for 3 times)

Mechanical shock resistance: 5 ms or less

Time constant: JIS C 0920 IP66 water-resistant type^(Note 3), non-water-proof for the connector of the connector type

Enclosure classification: Note 1: This sensor is adjusted under the following conditions before shipment at the factory.

- Ambient temperature 25°C ± 5°C
- Power supply voltage 24 V DC ± 1%
- Mounting position Horizontal (position in Figure 8)
- Reference atmospheric pressure for gauge pressure type

When span ≤ 2.5 MPa, let in atmospheric pressure through cable.

When span > 2.5 MPa, reference atmospheric pressure is 101.3 kPa abs.

Note 2: If the wetted part temperature exceeds 80°C, use a siphon to apply pressure to the sensor within 80°C.

Note 3: A requirement for water-resistant type pressure sensor is that no water must penetrate the sensor for 3 minutes when the water is omni-directionally jetted toward the sensor at a rate of 12.5 l/min at a pressure of 30 kPa from a distance of 3 m.

Note 4: Temperature effects (zero point reference value) for 0 to 50°C are as follows.

- ±0.015% of span/°C for the range of 200 kPa or more
- ±0.03% of span/°C for the range of 100 kPa, -100 kPa, -100 k to 100 kPa, or -100 k to 300 kPa
- ±0.06% of span/°C for the range of 10 kPa, 20 kPa, or 50 kPa

Note 5: <Reference> Formula for overall accuracy is shown below:

Overall accuracy is the amount of all errors such as accuracy, error caused by temperature change (temperature effect) and the like. The expression for overall accuracy is as follows.

- Span ≤ 2.5 MPa

Overall accuracy = ±√(Accuracy)² + (Temperature effect (zero point) × A)² + (Temperature effect (span) × A)²

- Span > 2.5 MPa

Overall accuracy = ±√(Accuracy)² + (Temperature effect (zero point) × A)² + (Temperature effect (span) × A)² + (Atmospheric pressure fluctuation error)²

A = Sensor temperature when measuring pressure - Temperature mentioned in the certificate

Temperature effect (span) [% of span/°C] = ±0.02 (reference value)

Atmospheric pressure fluctuation error = See Note 6.

Note 6: The sensor for gauge pressure type lets in reference atmospheric pressure through cable. When a span is more than 2.5 MPa, an error by atmospheric pressure fluctuation occurs because of its shield gauge construction. Reference atmospheric pressure is 101.3 kPa abs. Add the atmospheric pressure fluctuation error besides accuracy and temperature effects.

<Example> The atmospheric pressure fluctuation error for the range of 0 to 5 MPa is as follows:

- 0.02% of span when atmospheric pressure rises 1 kPa from 101.3 kPa abs.
- + 0.02% of span when atmospheric pressure drops 1 kPa from 101.3 kPa abs.

Note 7: <Measures against condensation>

Keep the sensor more than 30 cm apart from cooling piping by pressure inlet to make the temperature difference between the sensor and ambient temperature within 5°C.

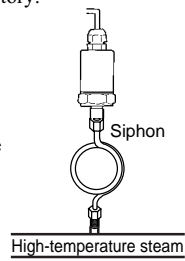


Figure 3

High-temperature steam

Siphon

Pressure inlet

Cooling piping

30 cm or more

Figure 4

Table 2 Model and Suffix Codes

Model	Suffix Code	Specifications
FP201		4 to 20 mA DC output for gauge-pressure measurement
FP201A		4 to 20 mA DC output for absolute-pressure measurement (Note 8)
Measuring range	-J -N -M -T -S -K -L -A -B -C -D -E -F -G -H	-100k to 0 kPa (gauge pressure) -100k to 100 kPa (gauge pressure) -100k to 300 kPa (gauge pressure) 0 to 10 kPa (gauge pressure) 0 to 20 kPa (gauge pressure) 0 to 50 kPa (gauge pressure), 0 to 50 kPa abs (absolute pressure) 0 to 100 kPa (gauge pressure), 0 to 100 kPa abs (absolute pressure) 0 to 200 kPa (gauge pressure), 0 to 200 kPa abs (absolute pressure) 0 to 500 kPa (gauge pressure), 0 to 500 kPa abs (absolute pressure) 0 to 1 MPa (gauge pressure), 0 to 1 MPa abs (absolute pressure) 0 to 2 MPa (gauge pressure), 0 to 2 MPa abs (absolute pressure) 0 to 5 MPa (gauge pressure), 0 to 5 MPa abs (absolute pressure) 0 to 10 MPa (gauge pressure) 0 to 20 MPa (gauge pressure) 0 to 35 MPa (gauge pressure)
Process connection	11 12 21 22 23 31 32 33 3B	G1/4 parallel thread for pipes (O-ring-sealed) G3/8 parallel thread for pipes (O-ring-sealed) G1/4 parallel thread for pipes (Gasket-sealed) G3/8 parallel thread for pipes (Gasket-sealed) G1/2 parallel thread for pipes (Gasket-sealed) R1/4 (Taper screw for pipes) R3/8 (Taper screw for pipes) R1/2 (Taper screw for pipes) R1 (Taper screw for pipes, with top of diaphragm shape)(Note 9)
Cable connection	-C -L	Connector Cable (Note 10)
Cable length	N 2 5 C	No cable (for connector type only) (Note 10) Provided with 2-m cable Provided with 5-m cable Provided with 10-m cable
Cable type	0	Always 0
Cable end treatment	A	Always A, preprocessed (pre-soldered)
Style code	+B	Style B
Option code	/B1 /B2	Degrease cleansing treatment Degrease cleansing and dehydrating treatment

Note 8: The FP201A absolute-pressure sensor has only seven measuring ranges: 50 kPa abs, 100 kPa abs, 200 kPa abs, 500 kPa abs, 1 MPa abs, 2 MPa abs, and 5 MPa abs.
Note 9: The ranges of 10 kPa, 20 kPa, 10 MPa, 20 MPa, and 35 MPa are not available for process connection "3B."
Note10: The combination of "-LN" is not available.

3.2 External Dimensions

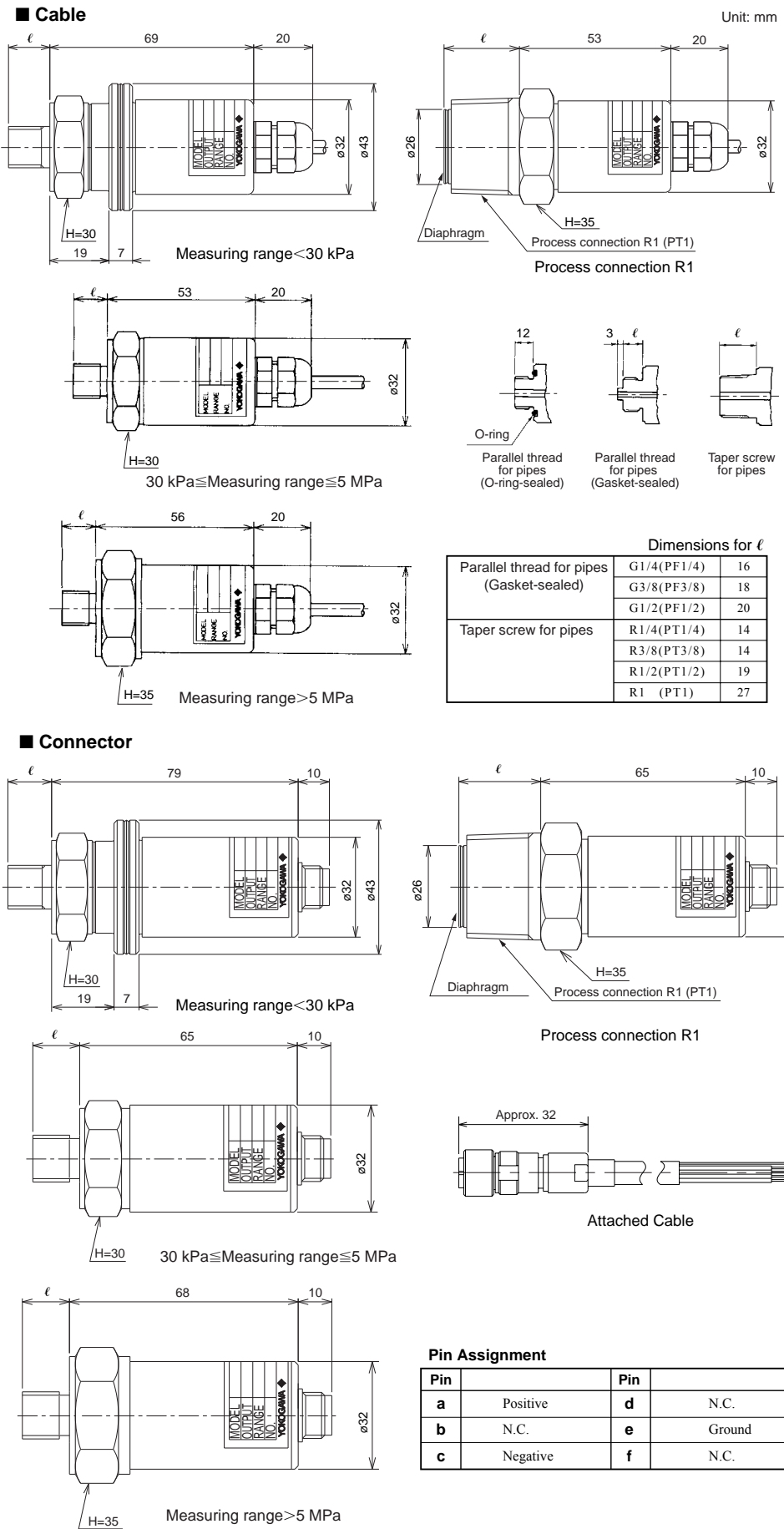


Figure 5 External Dimensions of FP201/FP201A

3.3 Components

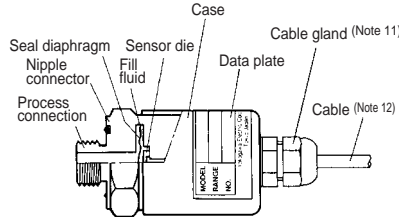


Figure 6 Components of FP201/FP201A

3.4 Relation between Pressure and Output Signal

The FP201/FP201A output signal is 4 to 20 mA DC proportional to pressure. As an example, Table 3 shows the relation between pressure and output signal of FP201 at the 0 to 1 MPa measuring range.

Note 11: Do not tighten or loosen the cable gland section. Failure to follow this instruction may result in damage to the soldered joints that connect the cable (lead wire) with the electronic circuit, due to the deterioration of tightness within the case or cable disconnection.
Note 12: Do not carry the sensor around by holding the cable.

Table 3 Pressure and FP201 Output Signal

Measuring Range		FP201 Output Signal
Pressure	% Display	
0 MPa	0 %	4 mA DC
0.25 MPa	25 %	8 mA DC
0.5 MPa	50 %	12 mA DC
0.75 MPa	75 %	16 mA DC
1.0 MPa	100 %	20 mA DC

Note: Example of 0 to 1 MPa measuring range

4. PREPARATION FOR OPERATION

4.1 Mounting the Sensor

Make sure there is no problem of application before mounting the sensor.



When starting up the system, take care not to apply the pressure to the sensor rapidly; for example, in an environment where valves are mounted nearby, manipulate the valves gradually. Even an instantaneous burst of pressure exceeding the maximum allowable pressure (see Table 1) may damage the sensor die.

- (1) When measuring liquid pressure, exercise care to prevent air bubbles from entering the nipple connector. (Whenever possible, mount the sensor so that the process connection faces upward.)
- (2) If impulse pressures are likely to occur within the piping (where the pressure exceeds the maximum allowable pressure), mount a damper (a fitting for dampening the pulsating pressure) to keep the pressure within the maximum allowable pressure (see Table 1 and Figure 2).
- (3) Securely mount the sensor by firmly tightening the hexagonal nut of nipple connector with a wrench.



Do not tighten the sensor by turning the case or cable gland assembly. Otherwise the sensor may be damaged. The recommended tightening torque is 40 N·m.

4.2 If Necessary, Treat the Ends of the Cable as Instructed Below

Cut the ends of the lead wires (soldered) when attaching solderless terminals to the + (red) and - (black) lead wires and ground lead wire. Choose the type of solderless terminals with a nominal size that fits the size of the terminal screw and the thickness of the lead wires. Since only the red and black lead wires are used, cut the white and green lead wires of 4-core cable.

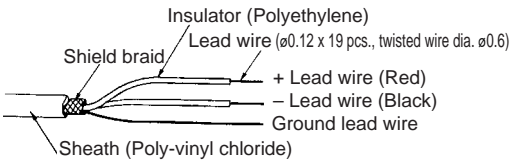


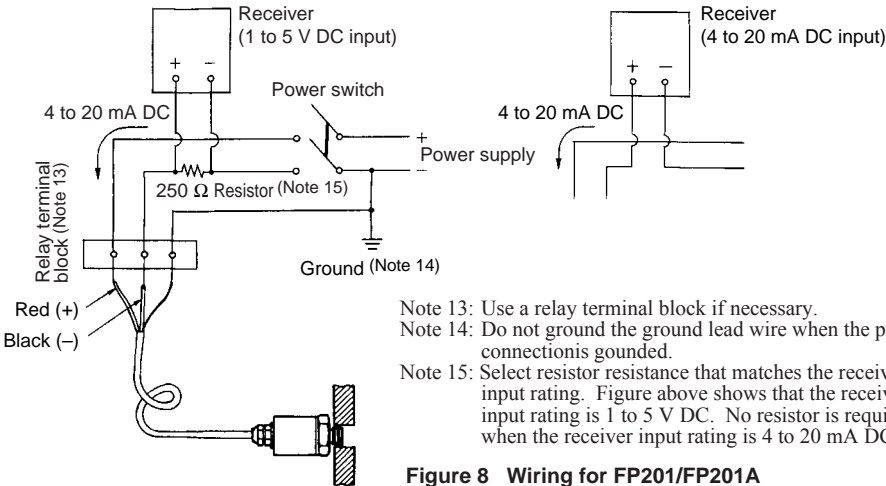
Figure 7 Cable of FP201/FP201A

4.3 Wiring the Sensor



Before wiring, turn off the power to the sensor.

When wiring the sensor, make sure the polarities are correct (see Figure 8). Be sure to ground the ground lead wire.



Note 13: Use a relay terminal block if necessary.
Note 14: Do not ground the ground lead wire when the process connection is grounded.
Note 15: Select resistor resistance that matches the receiver input rating. Figure above shows that the receiver input rating is 1 to 5 V DC. No resistor is required when the receiver input rating is 4 to 20 mA DC.

Figure 8 Wiring for FP201/FP201A

5. START OF OPERATION

- (1) Make sure the supply voltage is between 12 and 28 V DC (recommended voltage: 24 V DC ±10%).
- (2) Turn on the power to the sensor to start measurement.
- (3) Apply pressure equivalent to 0% of the measuring range and check that the receiver indicates 0%.

6. WARRANTY



- (1) This product is guaranteed for a period of one year from the date of delivery. Yokogawa Electric Corporation (hereinafter, simply referred to as Yokogawa) will replace the guaranteed part or parts of the product in question, free of charge, if the product fails during the guarantee period for reasons that are attributed to Yokogawa. The guarantee for this product becomes void if the failure is due to any of the following:
- Improper handling or misuse of the product by the user. (Including installation and use not observing this user's manual.)
 - Modification or repair by persons unauthorized by Yokogawa.
 - Acts of God, natural disasters, insurrections or any other cause beyond Yokogawa's control.
- Note that the guarantee referred to here only covers the delivered product; it does not apply to damage of any sort resulting from the failure of the delivered product.
- (2) This product is not designed or manufactured for use with equipment or systems that are operated under conditions that may endanger the lives of personnel.
- (3) The information in this user's manual is subject to change without notice.